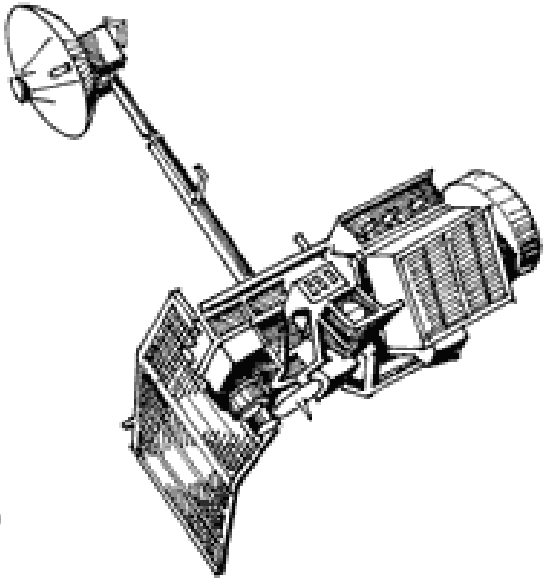
A land manager's evaluation of two remote sensing products to determine effectiveness of performing imagery analysis in-house.

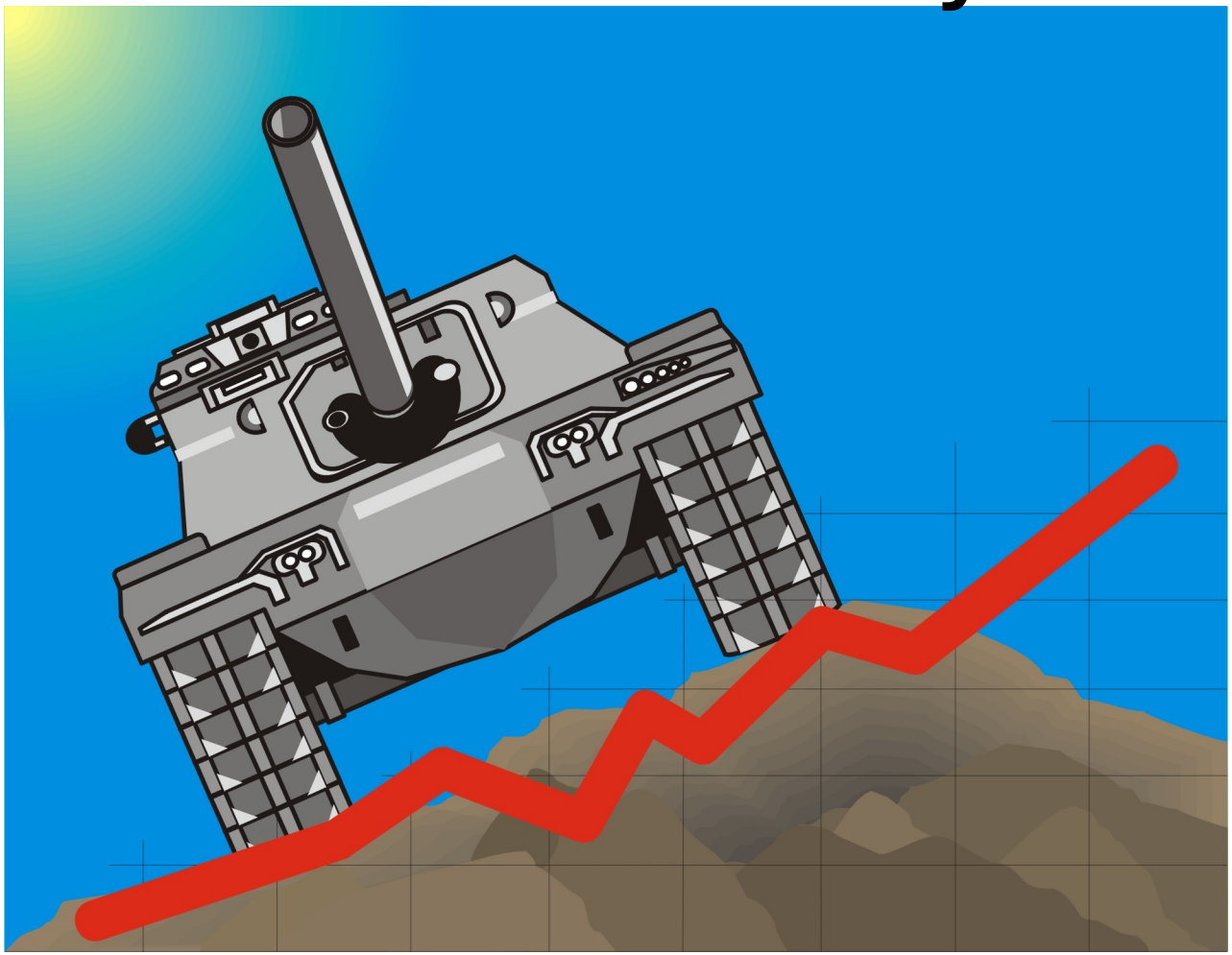


Brian Cochrane
Yakima Training Cente

What does an Army land manager need? And why?

The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land.
Aldo Leopold, 1948
The Army land manager must include training use in the definition of land.

What does an Army land manager need? And why?



To do that, one needs information (data) at varying spatial and temporal scales primarily to determine cause - effect

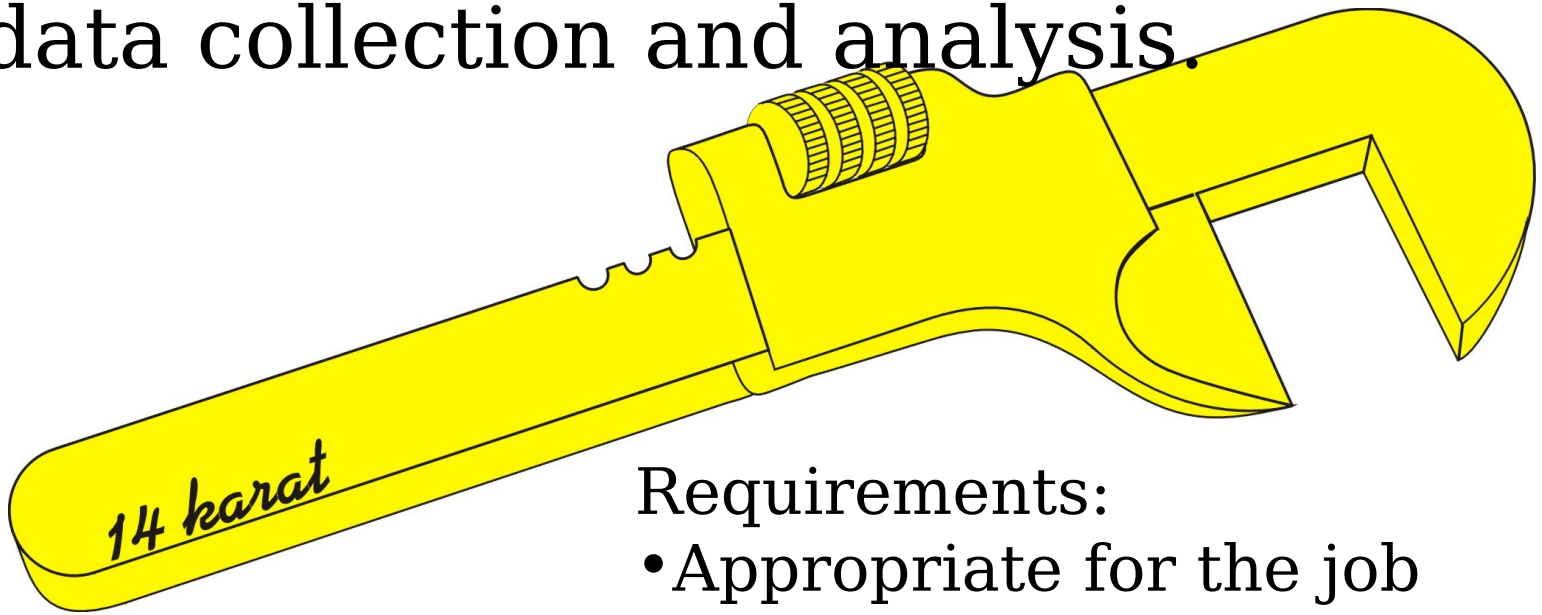
What does an Army land manager need? And why?

Tools to collect that kind of data traditionally have been labor intensive, providing detailed information at a few locations that must be extrapolated across larger areas.

What does an Army land manager need? And why?

Imagery products provide the opposite kind of information:
One data item about each piece of ground.

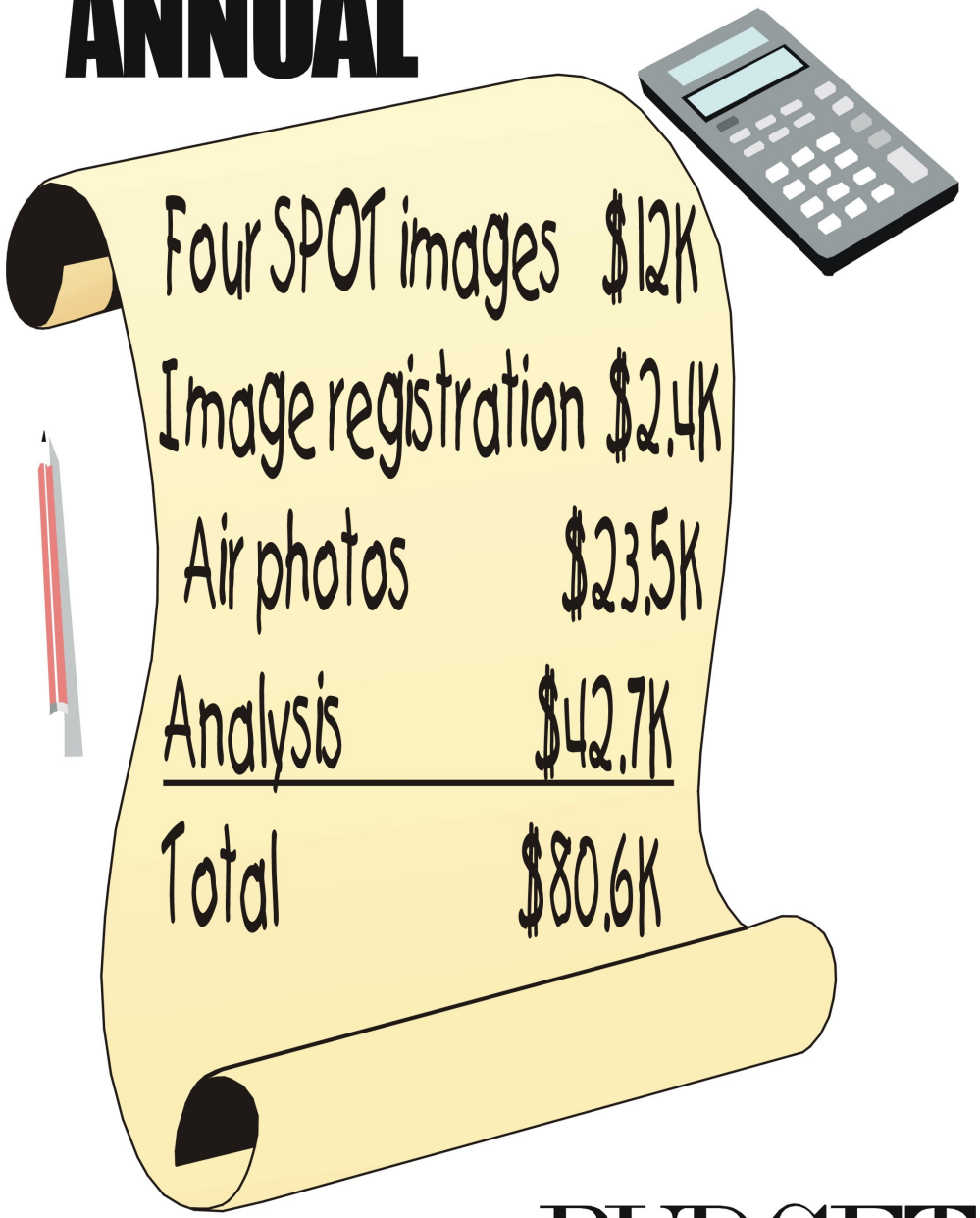
Imagery and the software to analyze it are tools to accomplish the job of data collection and analysis.



Requirements:

- Appropriate for the job
- Fit to the user
- Cost effective
- Easy to learn
- Durable and complementary to other tools in the

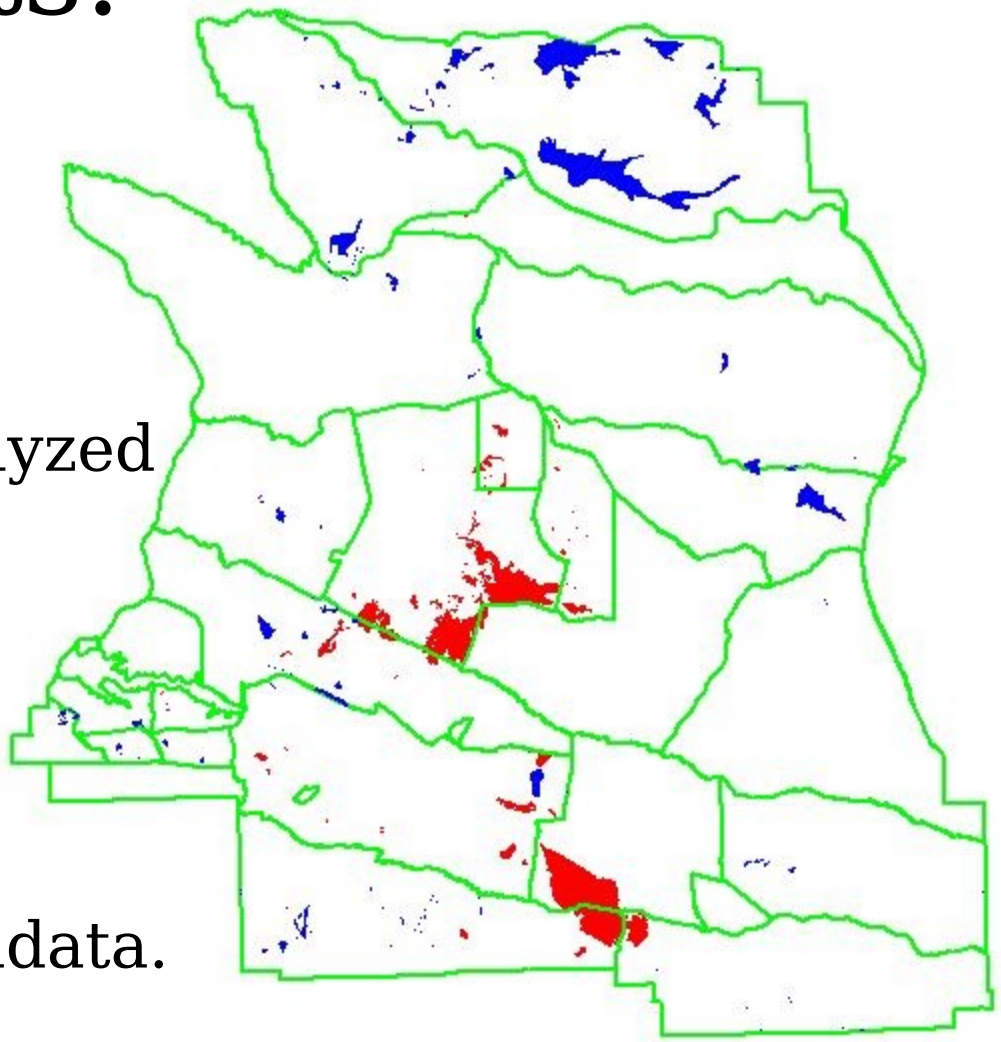
ANNUAL



BUDGET

YTC gets:

- 2+ products:
- Expertly analyzed
- 3-4 images
- Limited metadata.



YTC Provides:

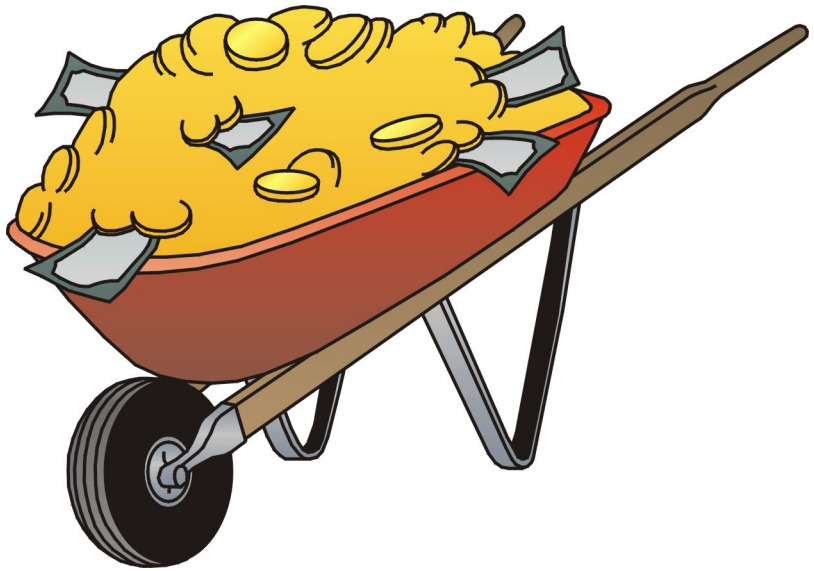
- SOWs
- Air photos for QC
- QC review of draft products

Alternatives

- Perform all data processing and analysis in house.
  - Advantage: Greatest flexibility and timeliness, local knowledge for QA.
  - Disadvantage: Limited staff time, initial lack of training and/or expertise.

Alternatives

- Continue status quo
  - Advantage: Easy, somewhat consistent, expert analysis.
  - Disadvantage: Cost, timeliness, no flexibility, no local knowledge.



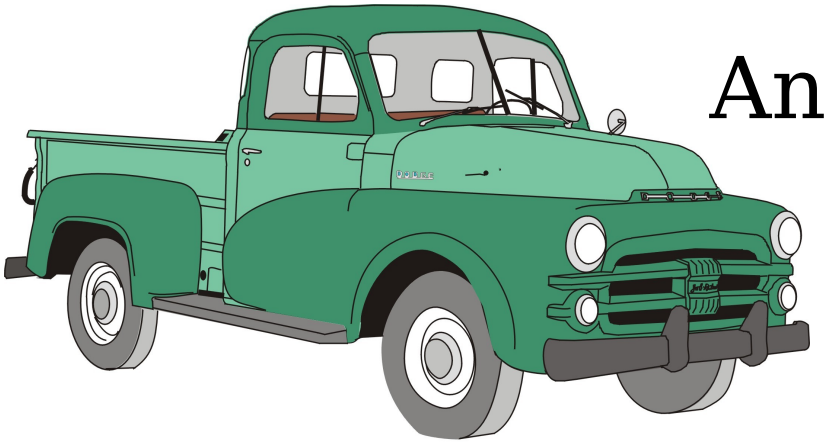
Alternatives

- Perform analysis and continue to have processing done outside
  - Advantage: Retain local knowledge for QA, retain flexibility, some decrease in staff time (though some QC of outside work will be required).
  - Disadvantage: initial lack of training and/or expertise.

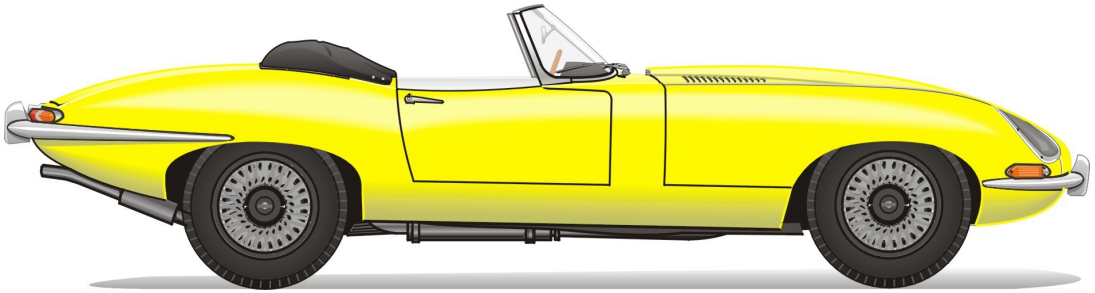
Which way do we want to go?

What vehicle will we use?

And can we afford the trip?

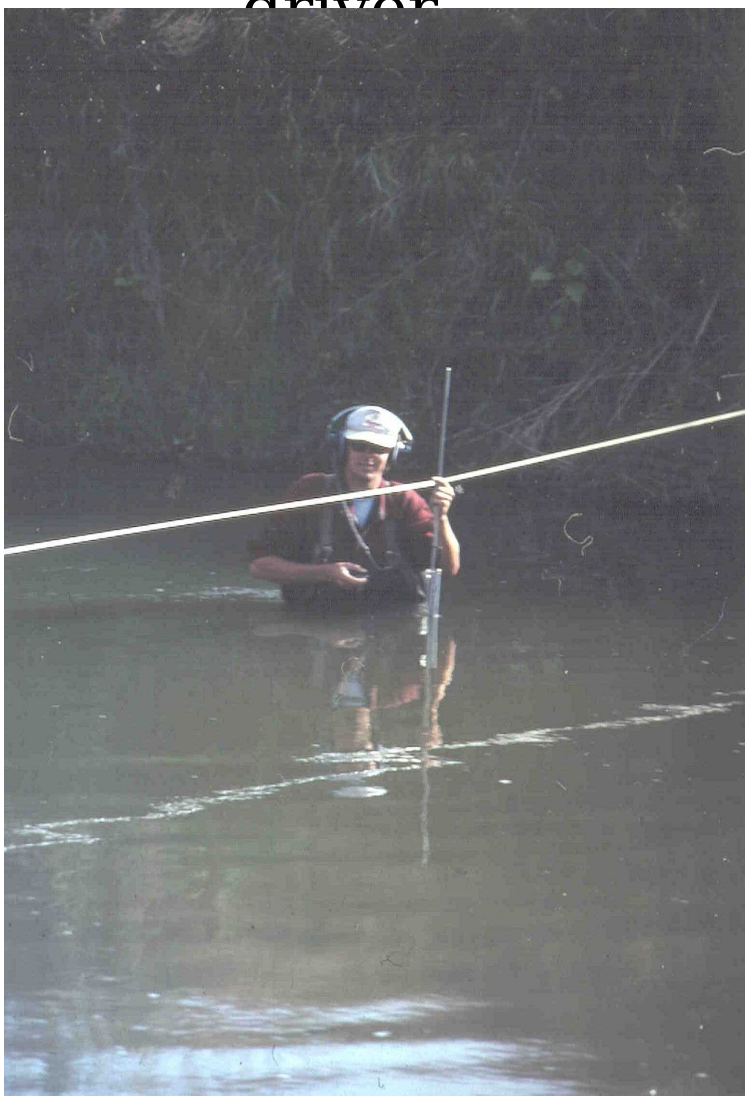


Or?

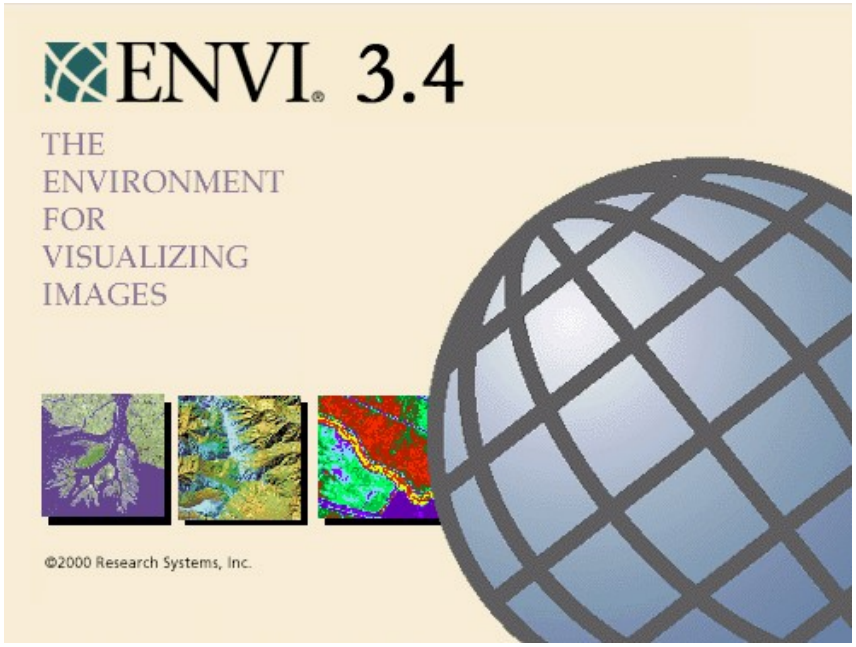


Let’s take a test drive …

And here’s the driver

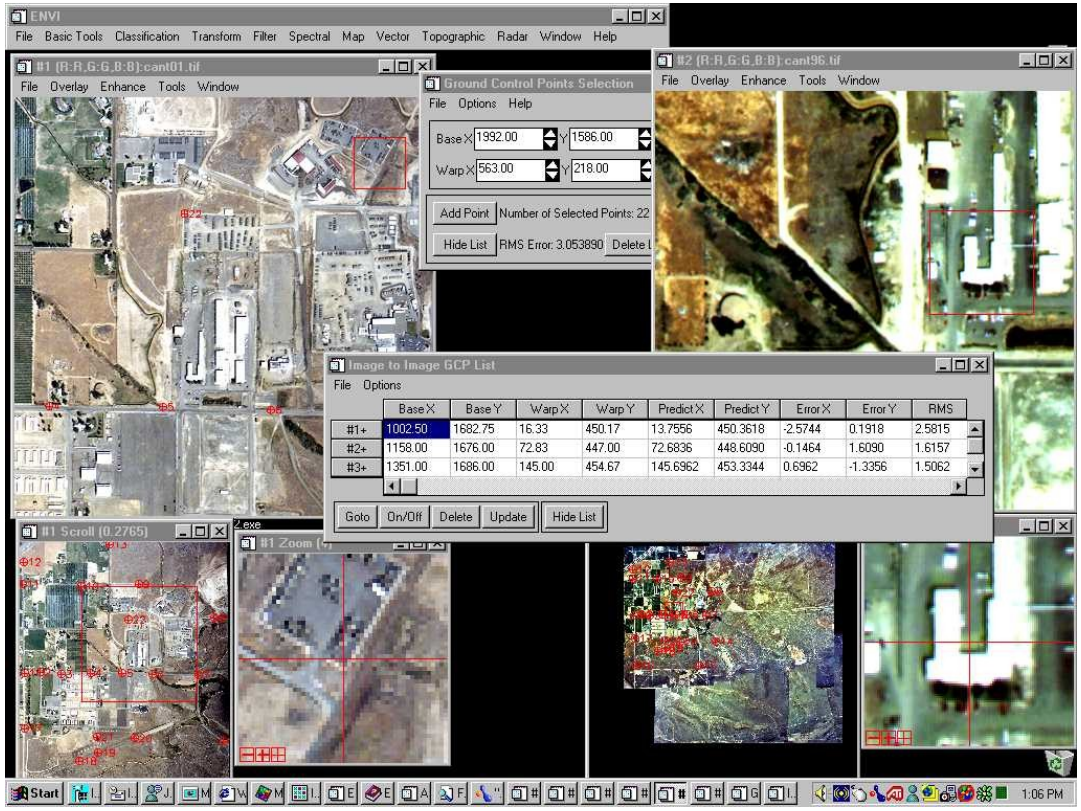


ENVI



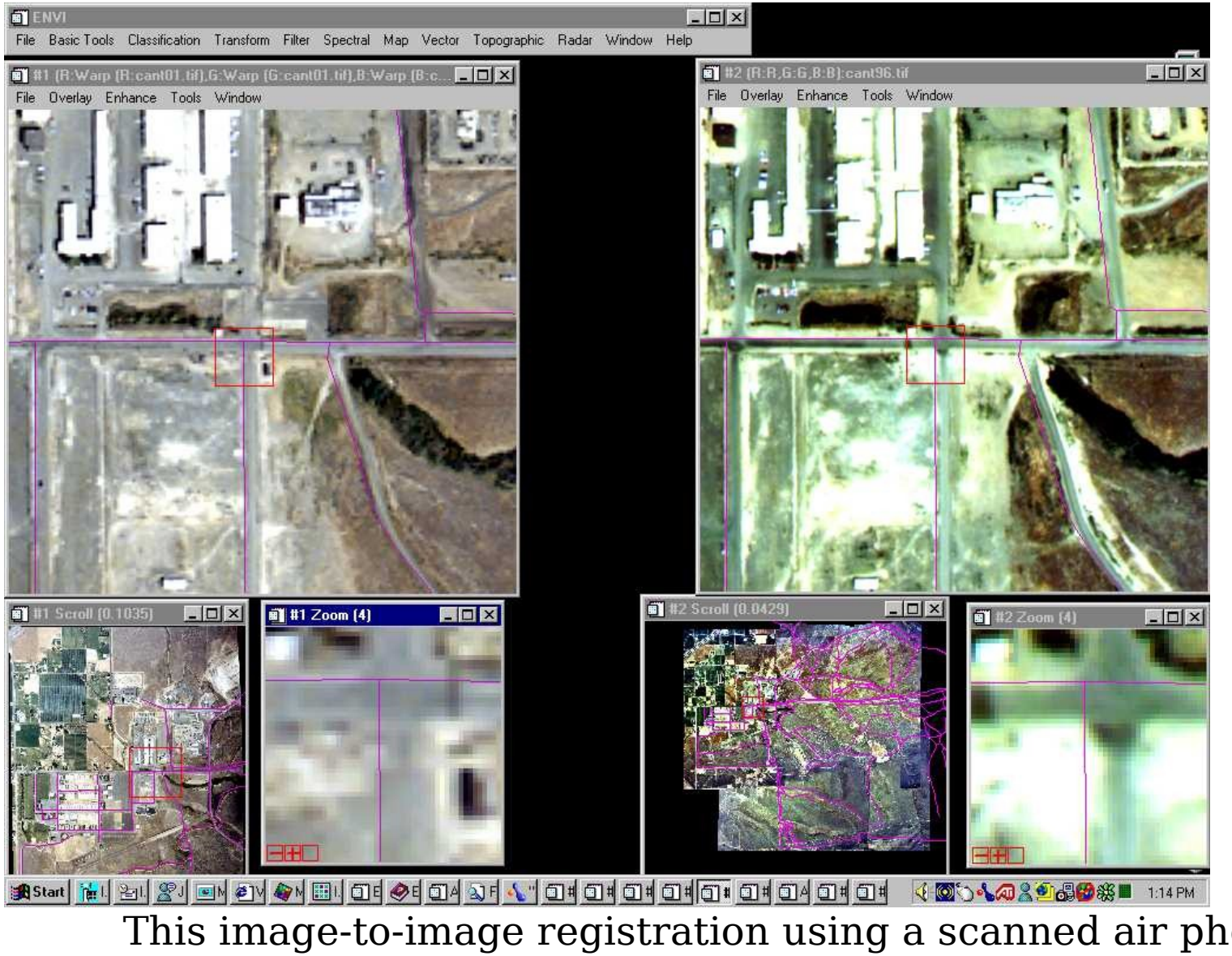
- ENVI one of several COTS analysis packages.
- Pan, Multi-spectral, Hyper-spectral, Radar, Lidar images from a variety of sources.
- Pre-processing (stretching, mosaicing, warping, rectification)
- Basic and advanced classification algorithms.
- Strong spectral analysis.
- Some vector and topographic capability.
- Used by PNNL for Hyperspectral analysis.
- Evaluation copy obtained for “teach the teacher program”, 2001.

Image registration (warping)


ENVI
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window Help
#1 (R:R,G:G,B:B):cant01.tif
File Overlay Enhance Tools Window
Ground Control Points Selection
File Options Help
Base X 1992.00 Y 1586.00
Warp X 563.00 Y 218.00
Add Point
Number of Selected Points: 22
Hide List
RMS Error: 3.053890
Delete
#2 (R:R,G:G,B:B):cant96.tif
File Overlay Enhance Tools Window
Image to Image GCP List
File Options
Base X | Base Y | Warp X | Warp Y | Predict X | Predict Y | Error X | Error Y | RMS
#1+ 1002.50 1682.75 16.33 450.17 13.7556 450.3618 -2.5744 0.1918 2.5815
#2+ 1158.00 1676.00 72.83 447.00 72.6836 448.6090 -0.1464 1.6090 1.6157
#3+ 1351.00 1686.00 145.00 454.67 145.6962 453.3344 0.6962 -1.3356 1.5062
Goto On/Off Delete Update Hide List
#1 Scroll (0.2765)
#1 Zoom
Start
1:06 PM

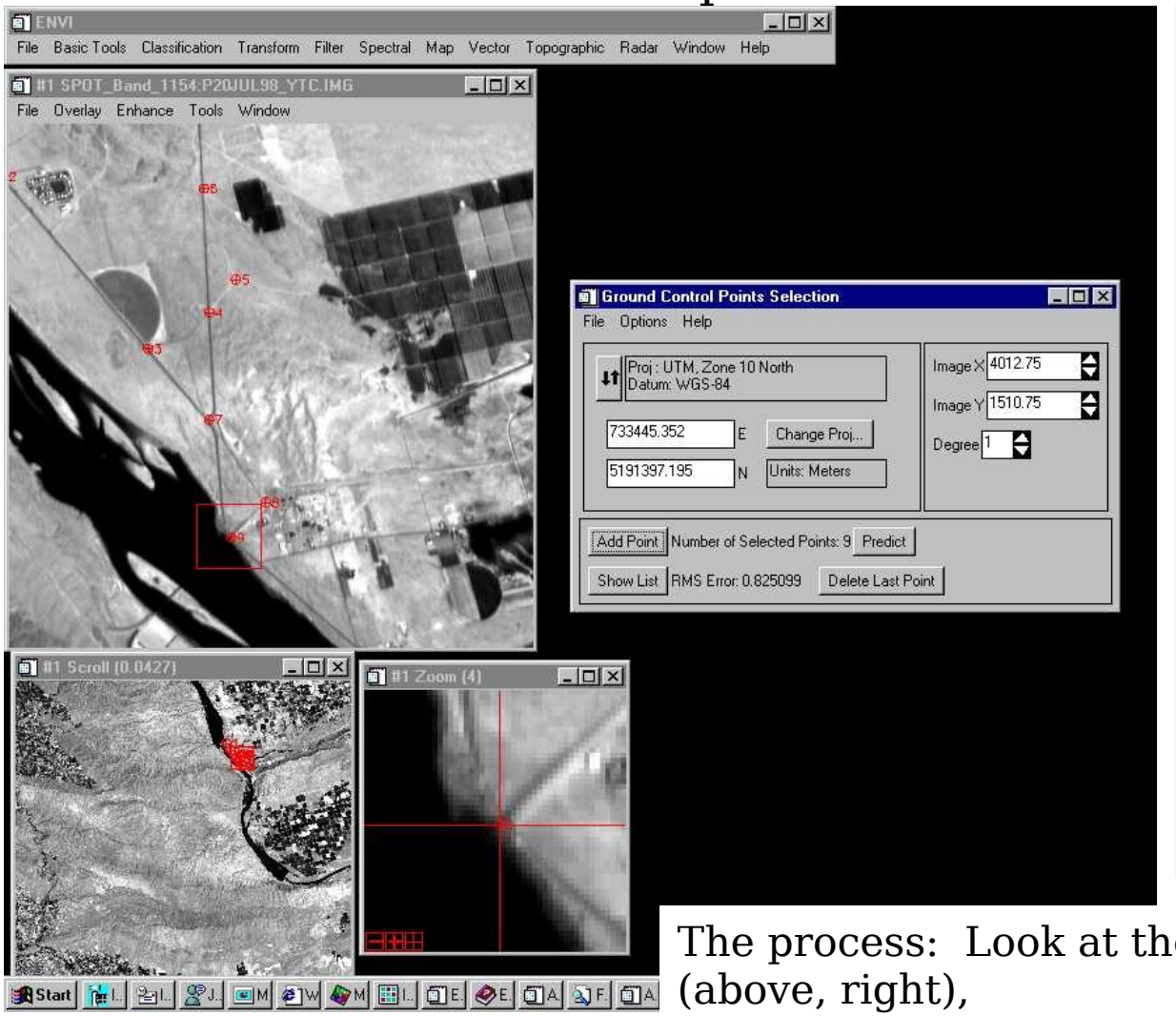
- Several choices of method. All must link an x,y location with a point on the image.
- Somewhat time consuming, depending on how clear the image is or how many similar features can be identified in both images if using image-to-image registration.
- Can do this in ArcGrid, but ENVI handles the task much better
- ENVI provides choices of warping method and re-sampling method

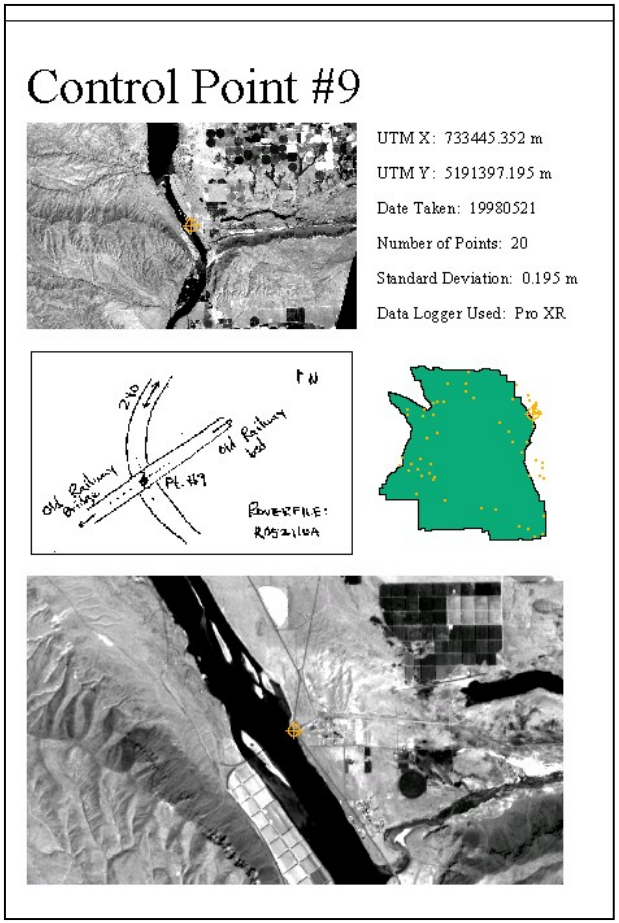
How’d I do?



This image-to-image registration using a scanned air photo and the high resolution cantonment image took about an hour.

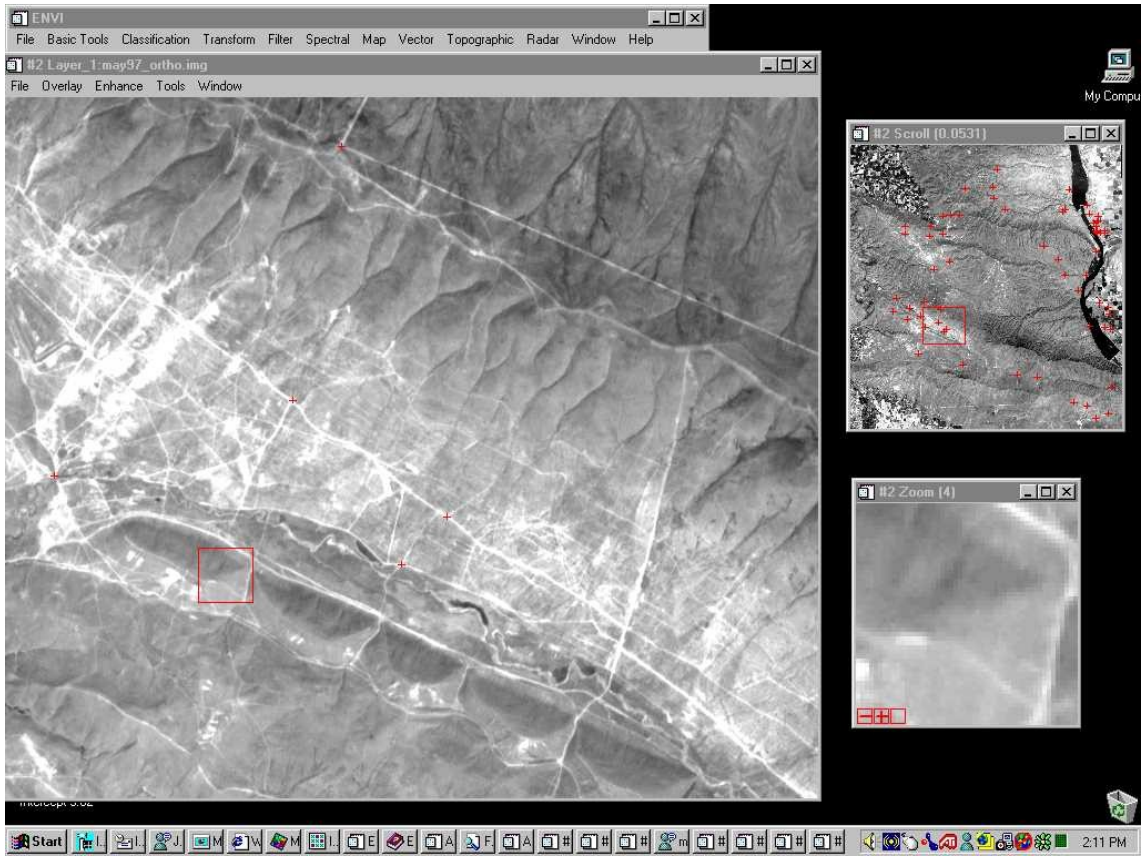
A second example using the YTC ground control point network.





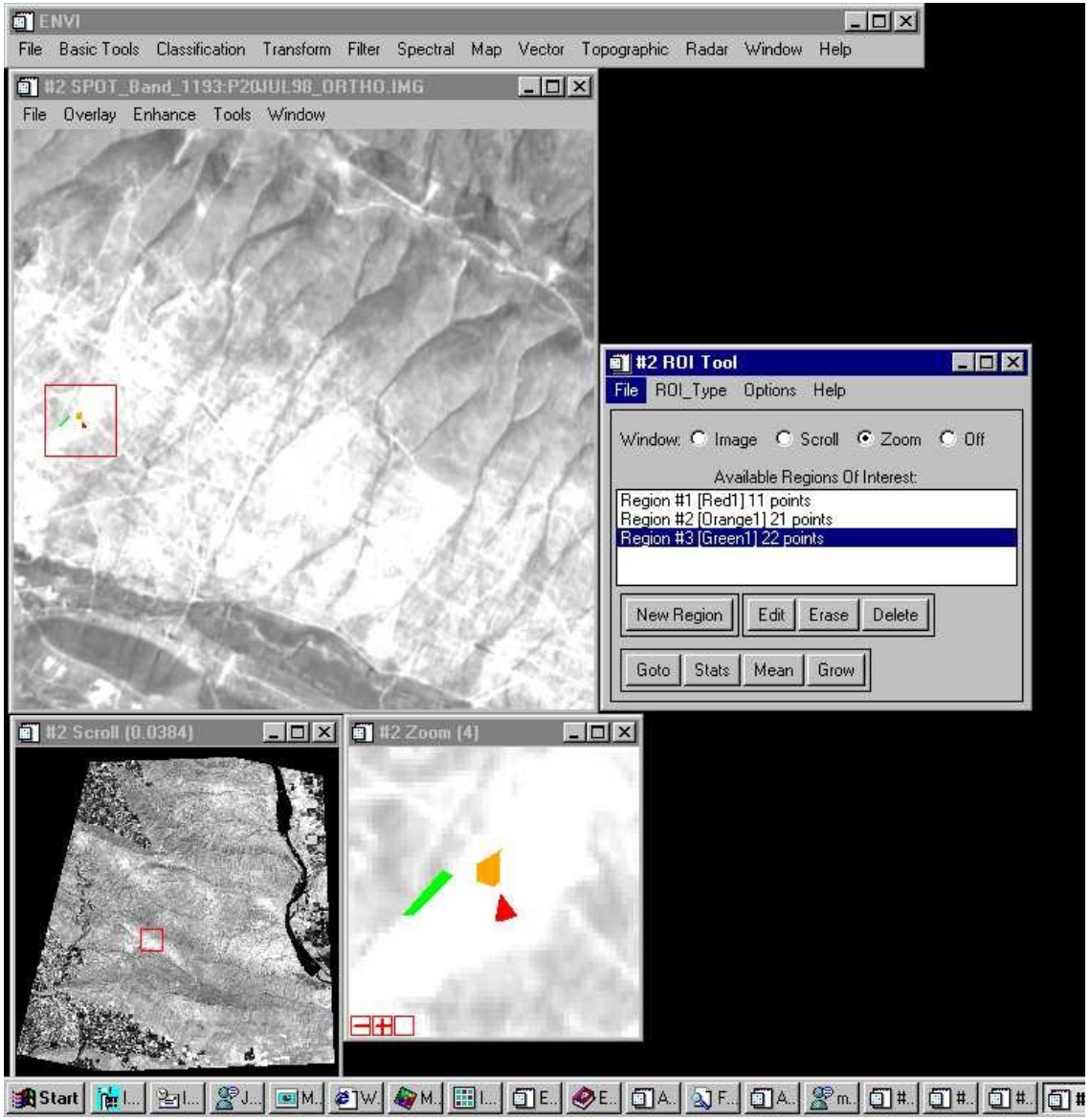
The process: Look at the book (above, right),
click where you think the control point is,
type in the x,y location.

You end up with an image like this:



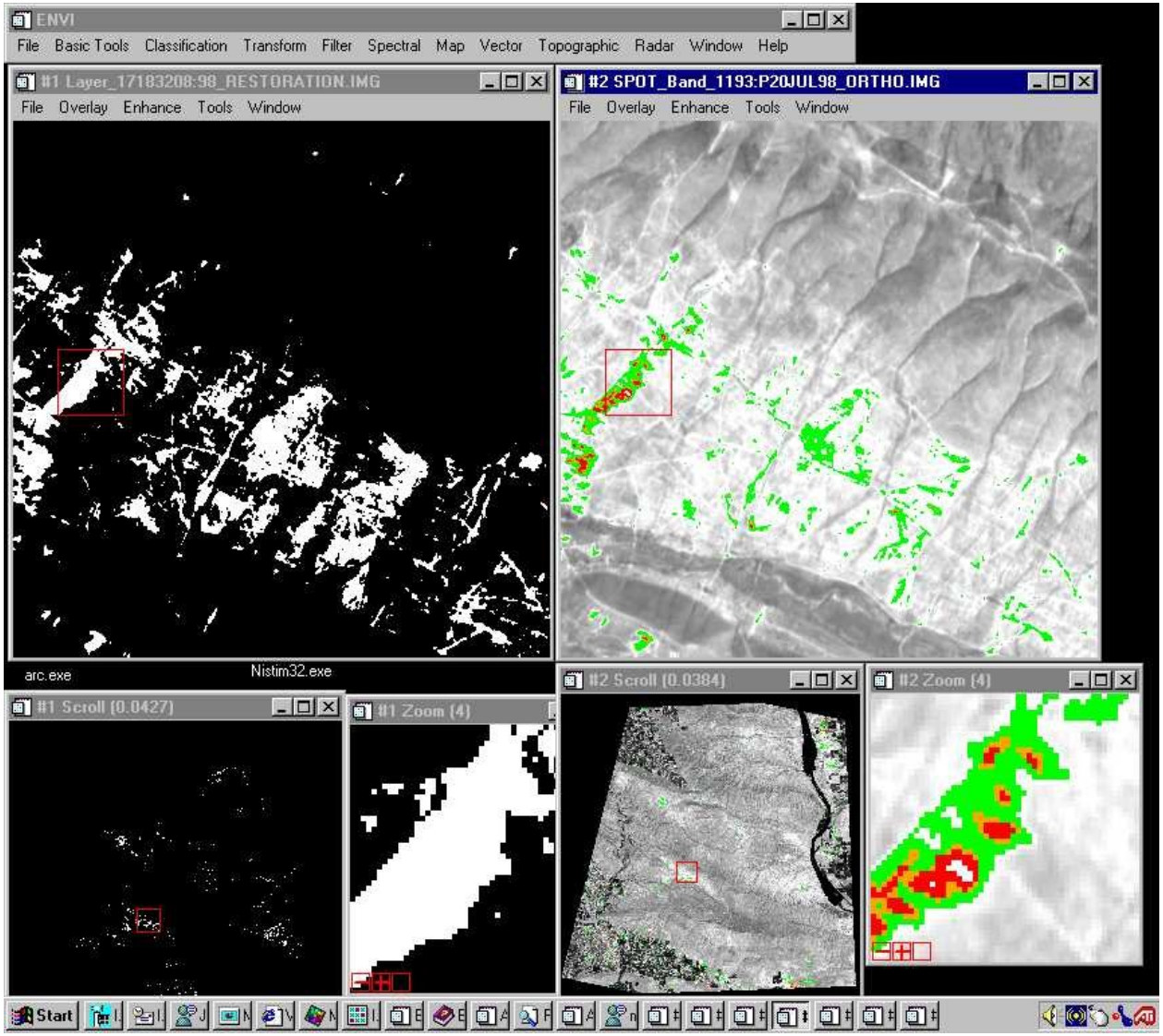
- Warped images compared favorably with other YTC images.
- Areas with higher density of control points and flatter terrain gave better results.
- Significant variation with different methods of image warp and re-sampling.
- Little documentation as to how images are registered.

Feature extraction


ENVI
File Basic Tools Classification Transform Filter Spectral Map Vector Topographic Radar Window Help
#2 SPOT_Band_1193:P20JUL98_ORTHO.IMG
File Overlay Enhance Tools Window
#2 ROI Tool
File ROI_Type Options Help
Window: Image Scroll Zoom Off
Available Regions Of Interest:
Region #1 [Red1] 11 points
Region #2 [Orange1] 21 points
Region #3 [Green1] 22 points
New Region Edit Erase Delete
Goto Stats Mean Grow
#2 Scroll (0.0384)
#2 Zoom (4)
Start

- Process
  - Define a region of interest
  - Tell software to find areas with similar spectral properties
  - In this case, we defined “disturbance”
    - Red = “heavy”
    - Amber = “medium”
    - Green = “light’

Not bad.

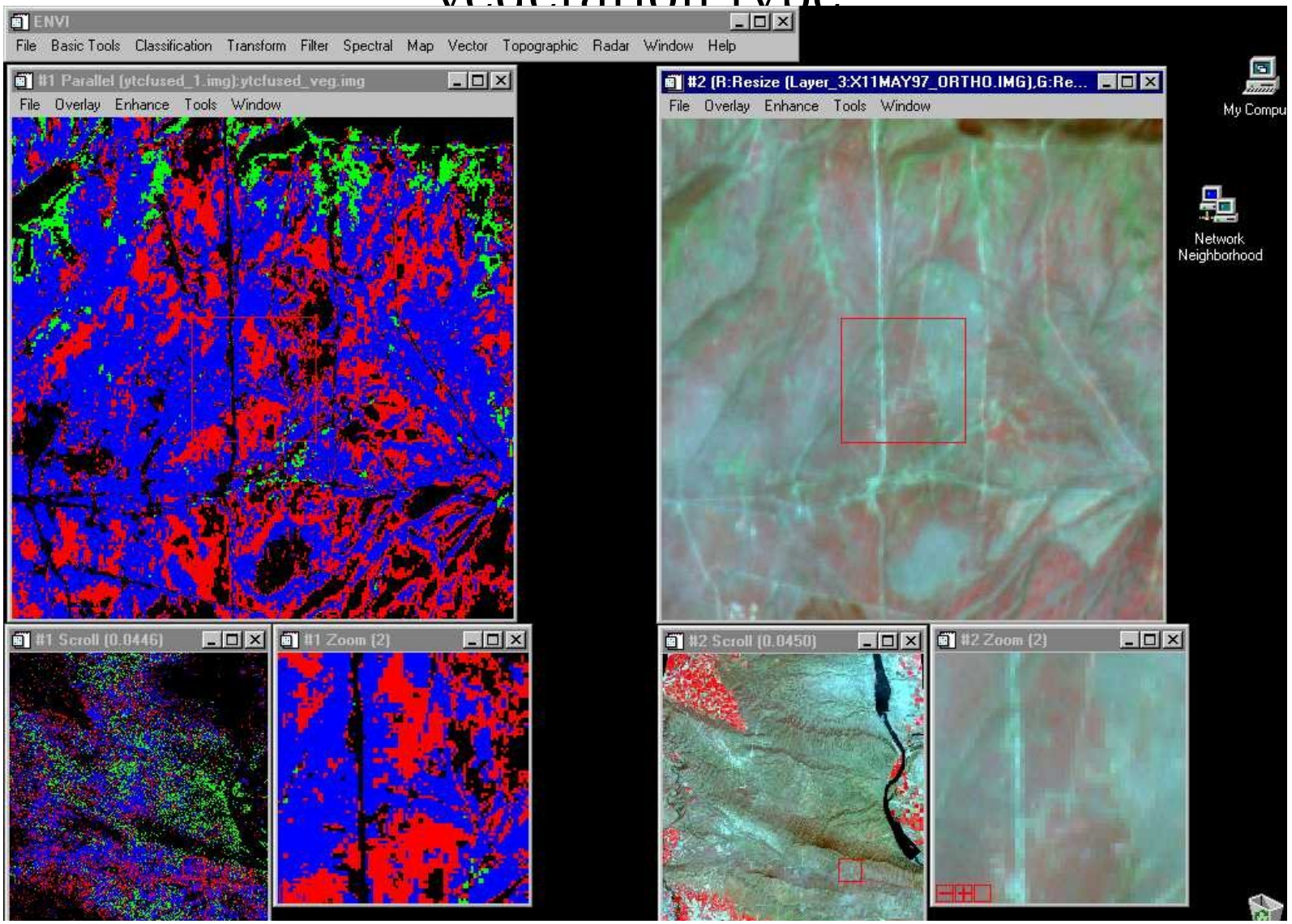


- Process took about an hour.
- Output varies depending on methods used.
- Probably underestimated “disturbance” (pixels that look like disturbed areas)
- Similar extraction of overgrazed areas in NEA
- Could experiment with effects of other extraction algorithms
- But not bad for a restoration map
- and we can do better …

Image merge

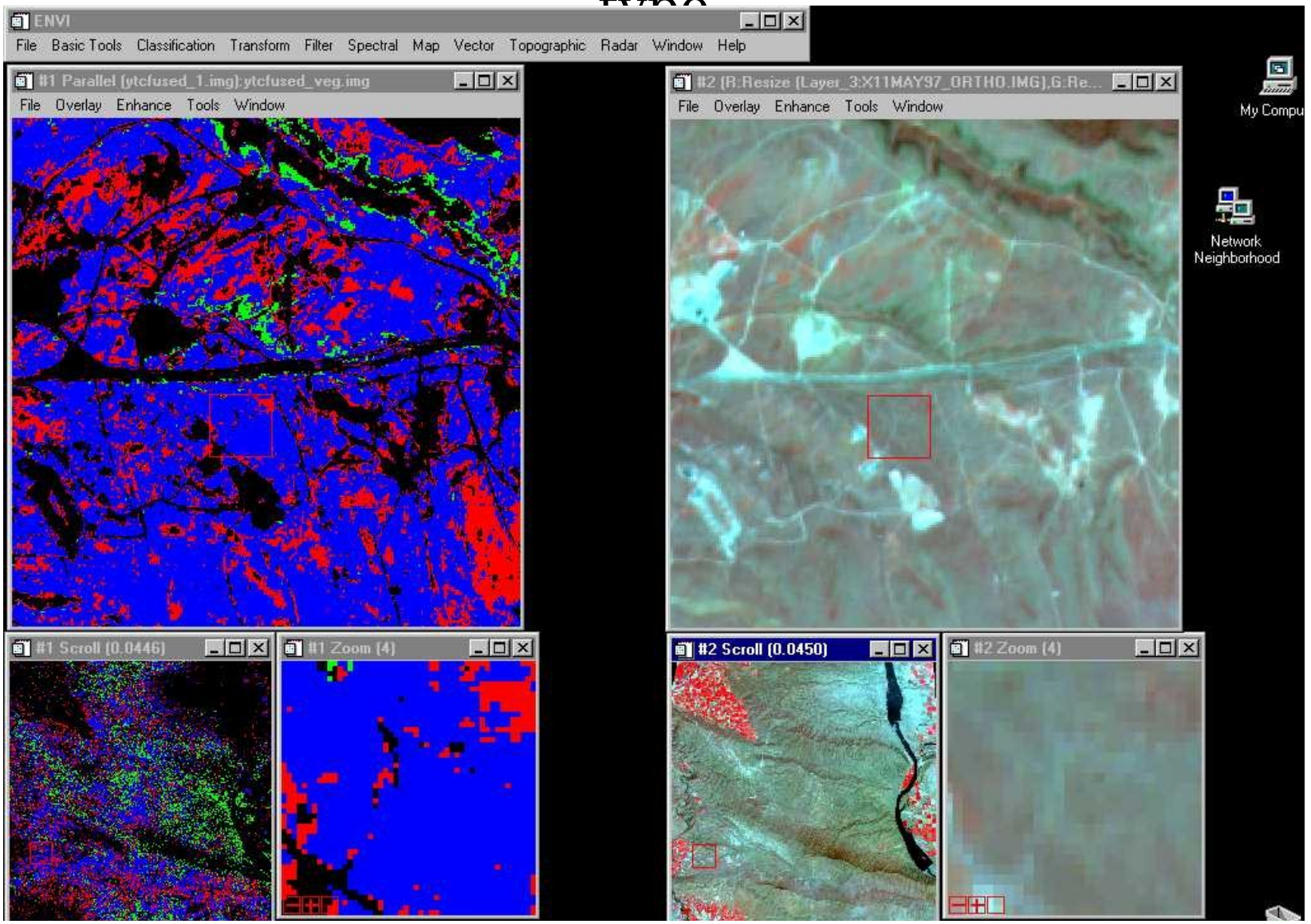
- Can combine images of same area that have different pixel sizes and bands sampled.
- In our case, we have Spot XS imagery (red, green, near infrared) at 20 meter pixel and Spot Pan at 10 meter pixel resolution.
- Infrared works well for identification of vegetation, so we might be able to extract vegetation classes or areas of no vegetation, e.g. disturbance.
- By merging images, we get the advantages of better spatial resolution with better spectral resolution.
- As a test, we classified the merged image using the TVIM sites as reference areas.
- Test took about an hour.

Merge classification results for grassland vegetation type



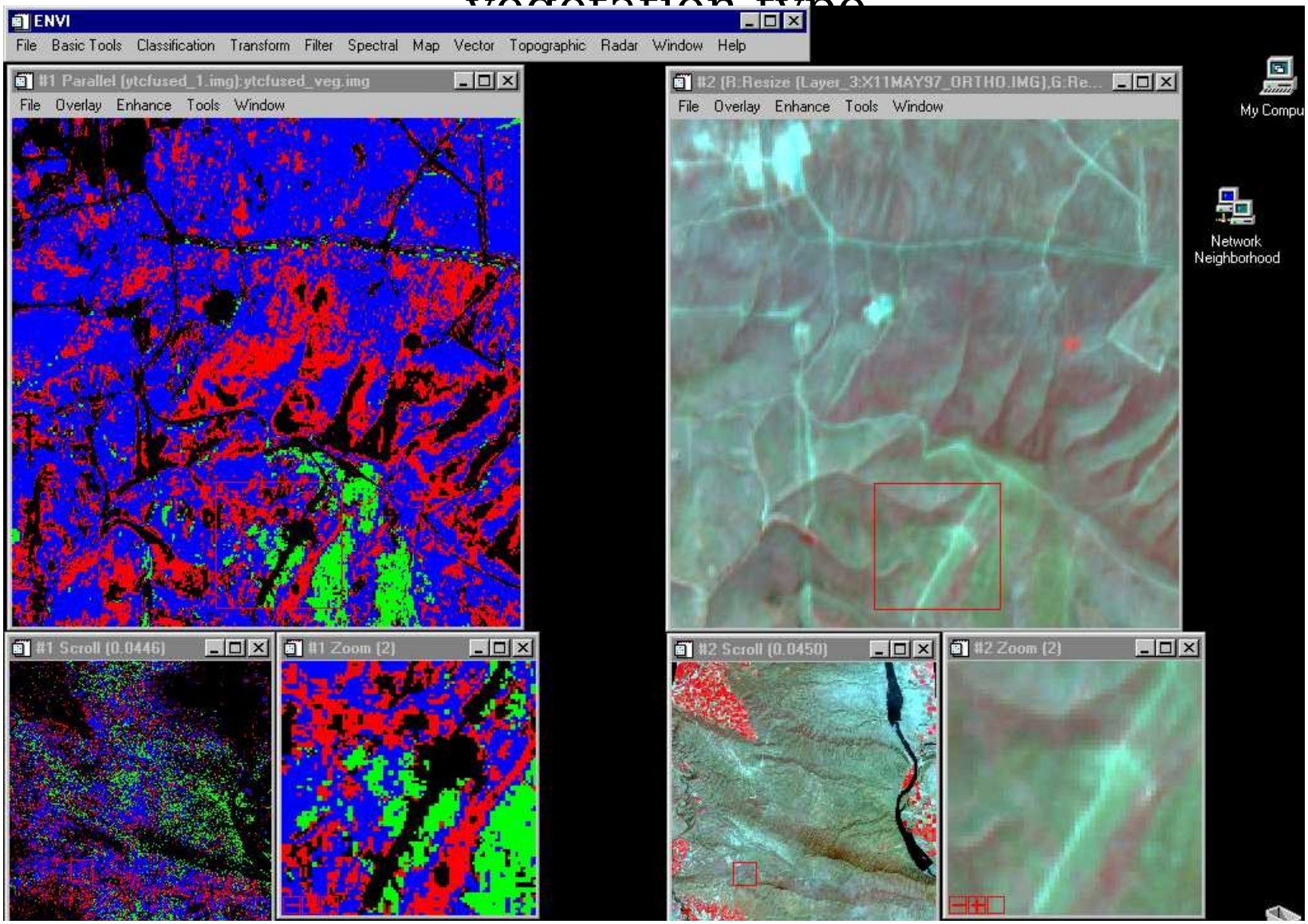
Grass = red; Blue = shrub; Green = shallows

Merge classification results for shrub vegetation type



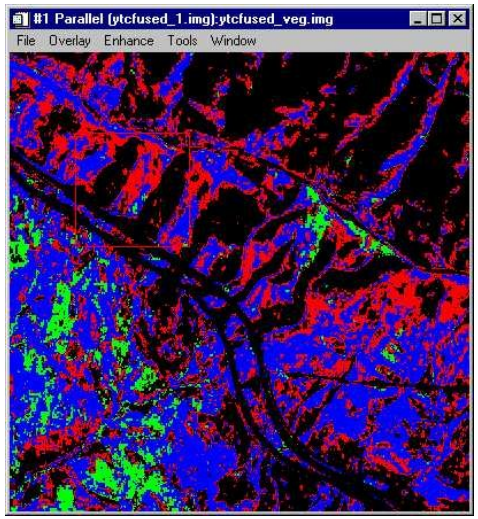
Grass = red; Blue = shrub; Green = shallows

Merge classification results for shallows vegetation type

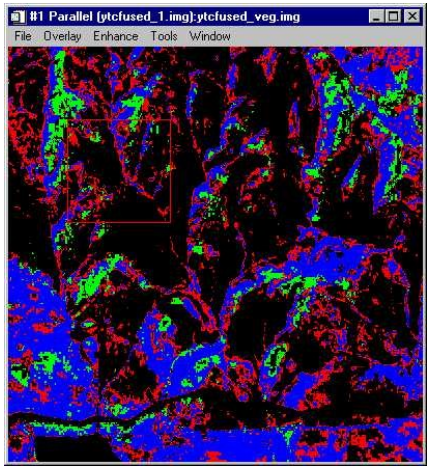


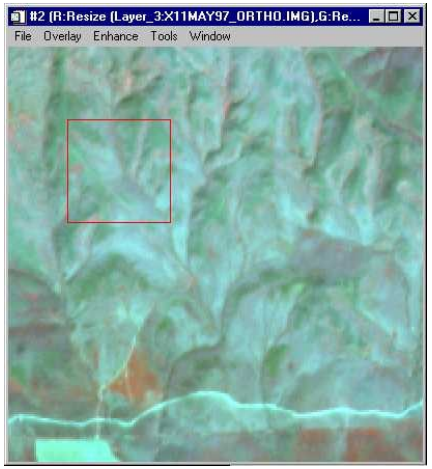
Grass = red; Blue = shrub; Green = shallows

Other interesting findings:



North slopes classified, south slopes not classified



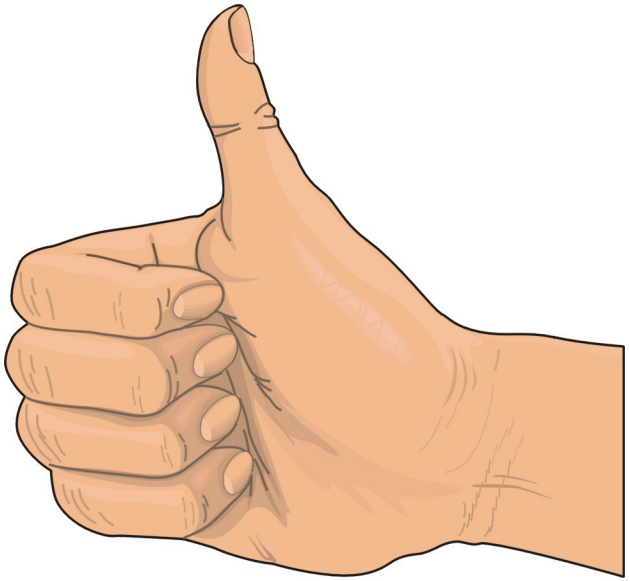


Crested wheatgrass planting from 1987 not well classified. This is expected since we did not define this area as a ROI.

Fire

- Supervised classification very difficult due to:
  - burn intensity
  - fuel type
  - recovery
  - underlying soils
- PNNL uses change detection and lots of ground truth to extract fire areas.
- Other techniques available
  - NVDI
  - Use Near IR or band ratios?
  - Might be able to use hyper-spectral techniques with multi-spectral data.

ENVI 1st Impressions



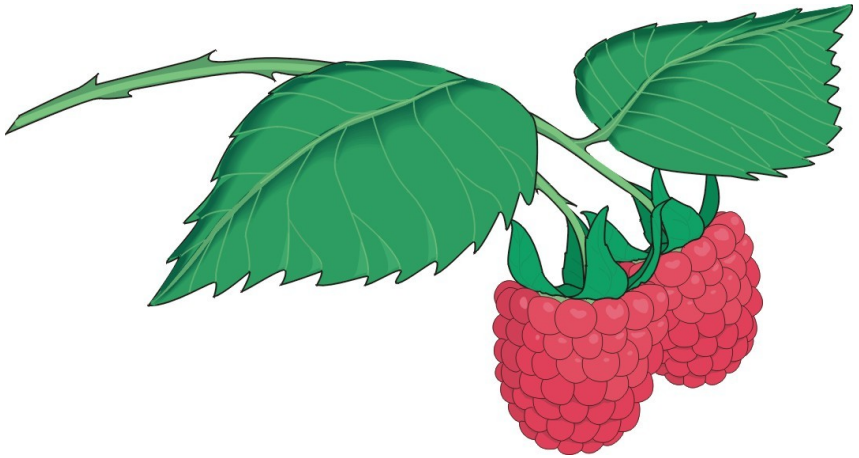
Pros

- Easy to use. Tutorial and help files wonderful.
- Handles variety of data sources
- Strong classification and hyper-spectral functions
- Lightweight (a warp of YTC takes ~ 5 minutes)
- Pretty good data for relatively small time investment.

ENVI 1st Impressions

Cons

- Not directly compatible with ArcInfo (must export coverages to shapefiles or export files)
- Generates lots of windows
- Registration could be a tiny bit better.
- Image-to-image change detection not obvious (it's buried in the "math" option).



ERDAS Imagine

Software
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Support
Leica Geosystems
ERDAS
HOME:: Software:: ERDAS Products:: IMAGINE Professional:: IMAGINE Professional Overview::
SOFTWARE
Go ahead, take all the credit.
(IMAGINE Professional : IMAGINE Professional Overview)
Features
• Supervised, unsupervised and hybrid land cover classification techniques to make production of land use maps easy
• Advanced tools for evaluating the quality and input training data and the resulting thematic maps, essential for ensuring and assessing classification accuracy
• IMAGINE Expert Classifier- this tool does the thinking for you by allowing you to build and execute geographic expert systems for image classification, post classification refinement, and advanced GIS modeling
• Model Maker- a unique, object-based interface for integrated raster and vector spatial analysis, as well as the design of new image processing techniques
• State-of-the-art tools for pre-processing and analyzing radar data
click to view
Features
Key Capabilities
• IMAGINE Essentials tools
• All IMAGINE Advantage tools
• Advanced classification
• Model Maker graphical spatial analysis
• Advanced radar image analysis
Add-On Modules for IMAGINE Professional:
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ERDAS Products
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Product Walk-Throughs
Product Enhancements
Sales Contacts
What's New in IMAGINE 8.5
What's New in IMAGINE 8.4
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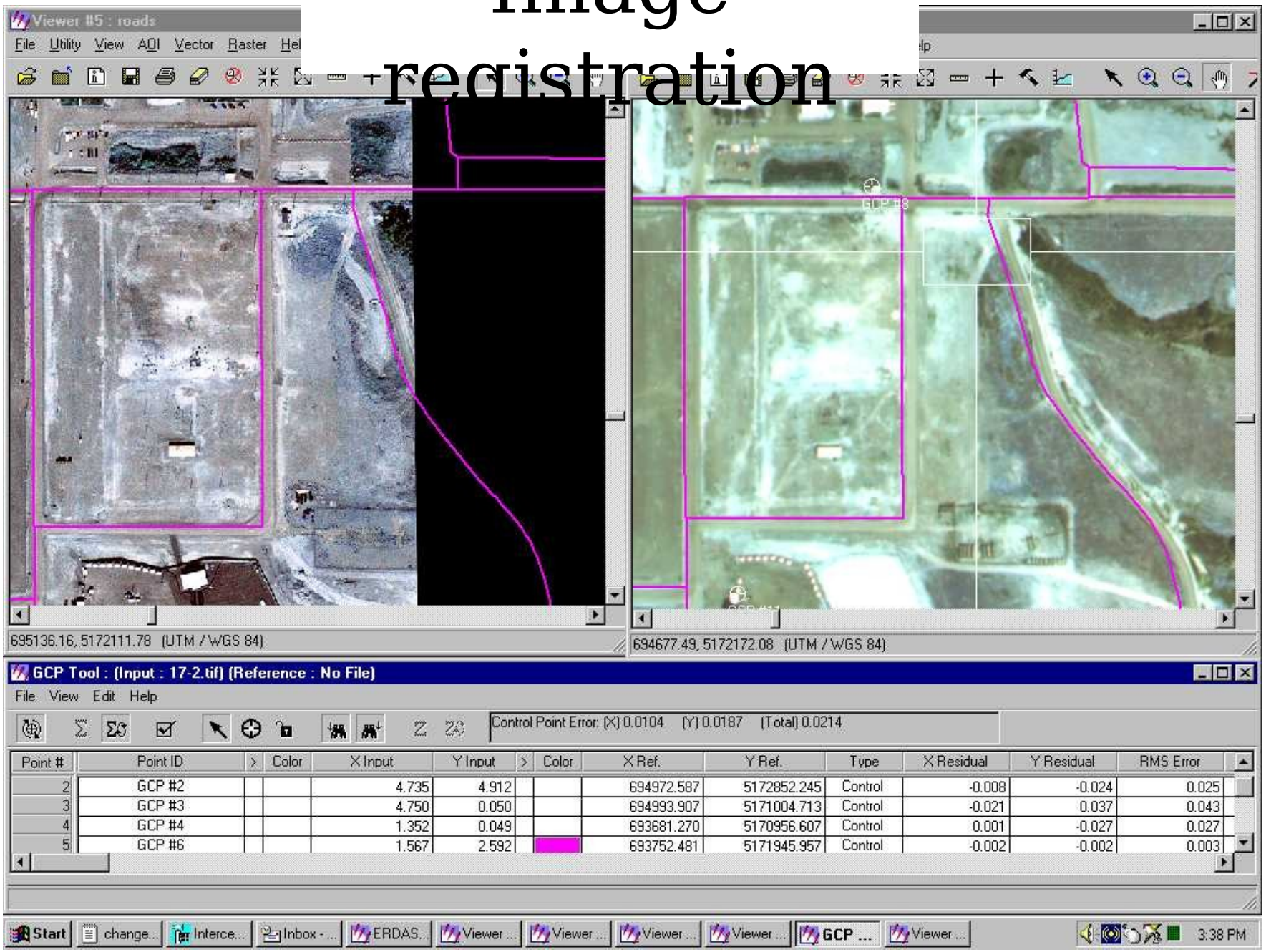
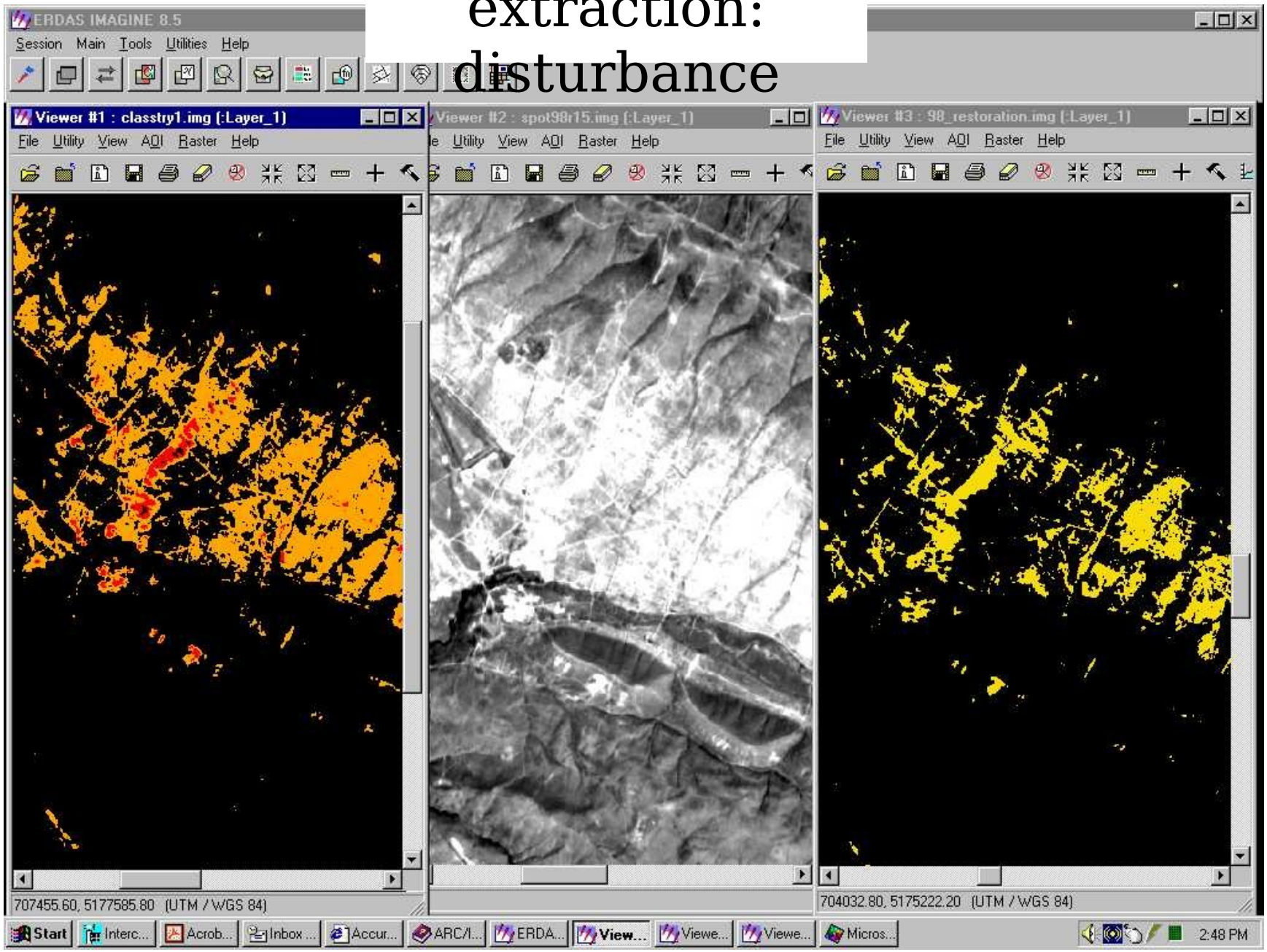
- Probably THE image analysis package in terms of users.
- Like ENVI, handles images from a variety of sources.
- User definable models.
- Good vector and topographic capability.
- 60 day evaluation copy obtained for our “test drive”, 2002.

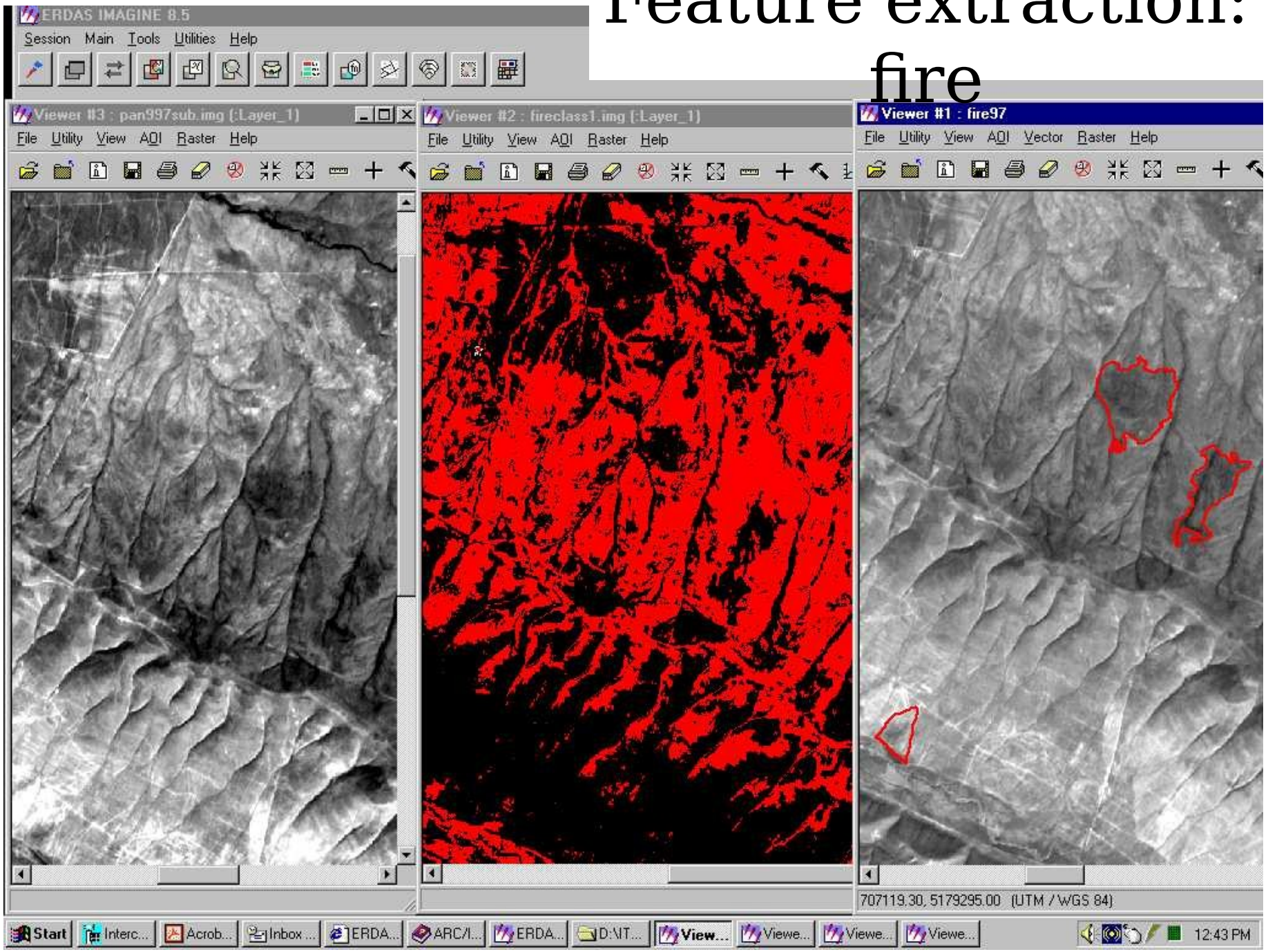
Image registration


Viewer #5 : roads
File Utility View AOI Vector Raster
695136.16, 5172111.78 (UTM / WGS 84)
694677.49, 5172172.08 (UTM / WGS 84)
GCP Tool : (Input : 17-2.tif) (Reference : No File)
File View Edit Help
Control Point Error: (X) 0.0104 (Y) 0.0187 (Total) 0.0214
Point # | Point ID | Color | X Input | Y Input | Color | X Ref. | Y Ref. | Type | X Residual | Y Residual | RMS Error
2 | GCP #2 | 4.735 | 4.912 | 694972.587 | 5172852.245 | Control | -0.008 | -0.024 | 0.025
3 | GCP #3 | 4.750 | 0.050 | 694993.907 | 5171004.713 | Control | -0.021 | 0.037 | 0.043
4 | GCP #4 | 1.352 | 0.049 | 693681.270 | 5170956.607 | Control | 0.001 | -0.027 | 0.027
5 | GCP #6 | 1.567 | 2.592 | 693752.481 | 5171945.957 | Control | -0.002 | -0.002 | 0.003
Start
change...
Interce...
Inbox - ...
ERDAS...
Viewer ...
GCP ...
3:38 PM

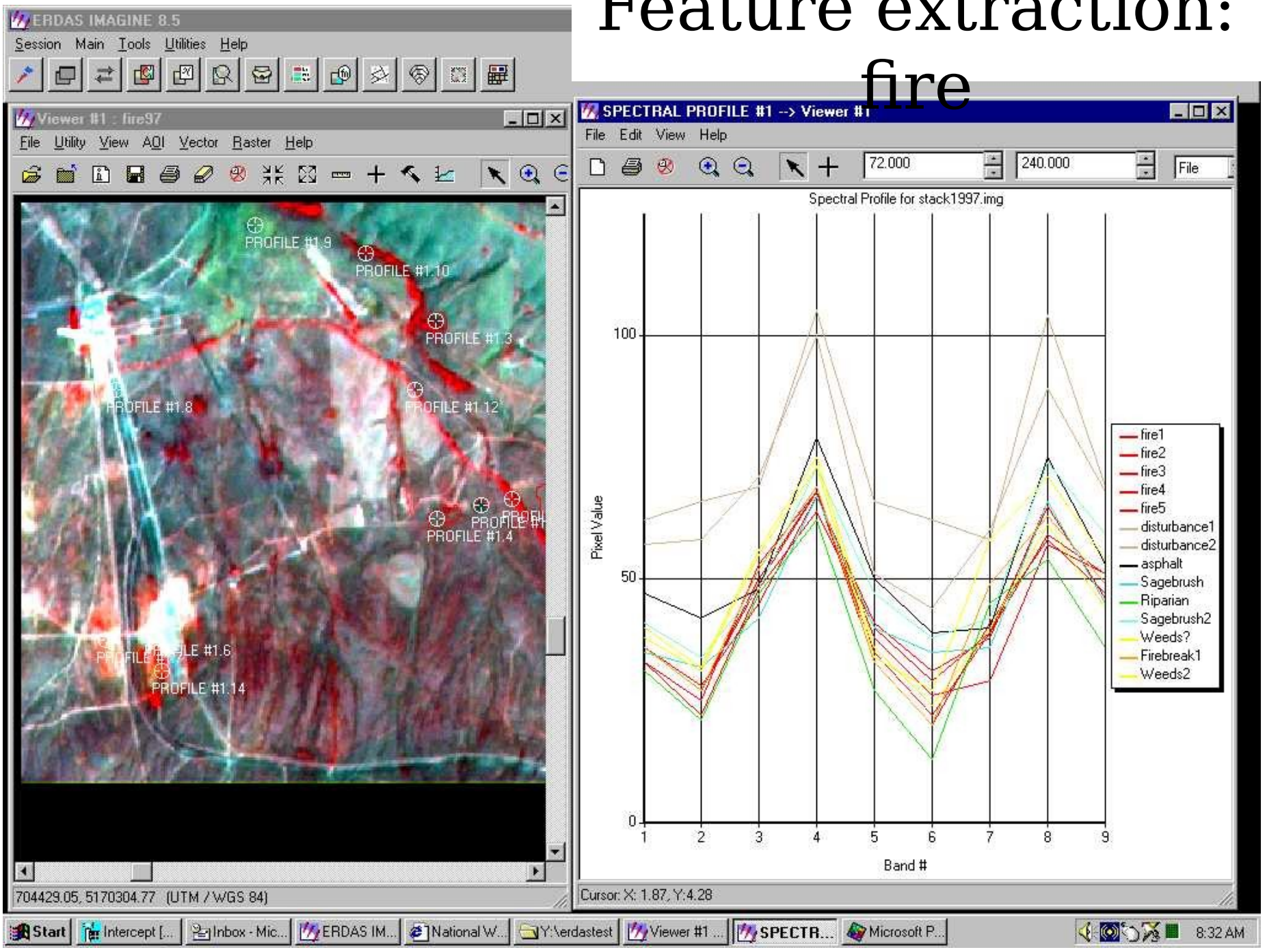
Feature extraction: disturbance



Feature extraction: fire


ERDAS IMAGINE 8.5
Session Main Tools Utilities Help
Viewer #3 : pan997sub.img (:Layer_1)
File Utility View AOI Raster Help
Viewer #2 : fireclass1.img (:Layer_1)
File Utility View AOI Raster Help
Viewer #1 : fire97
File Utility View AOI Vector Raster Help
707119.30, 5179295.00 (UTM / WGS 84)
Start
12:43 PM

Feature extraction: fire



Imagine 1st Impressions

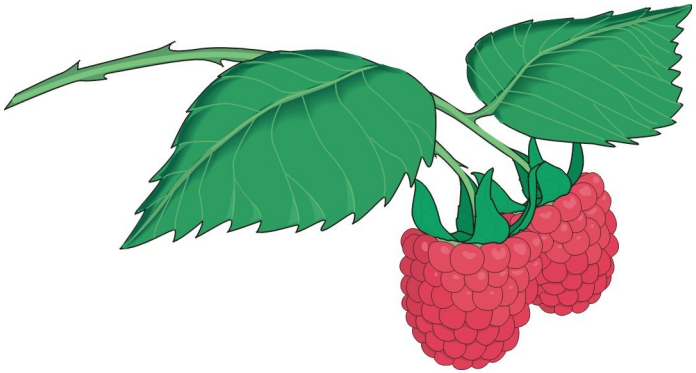
Pros

- Easy to use.
- Handles variety of data sources.
- Well integrated with Arc.
- Strong feature extraction and registration functions.

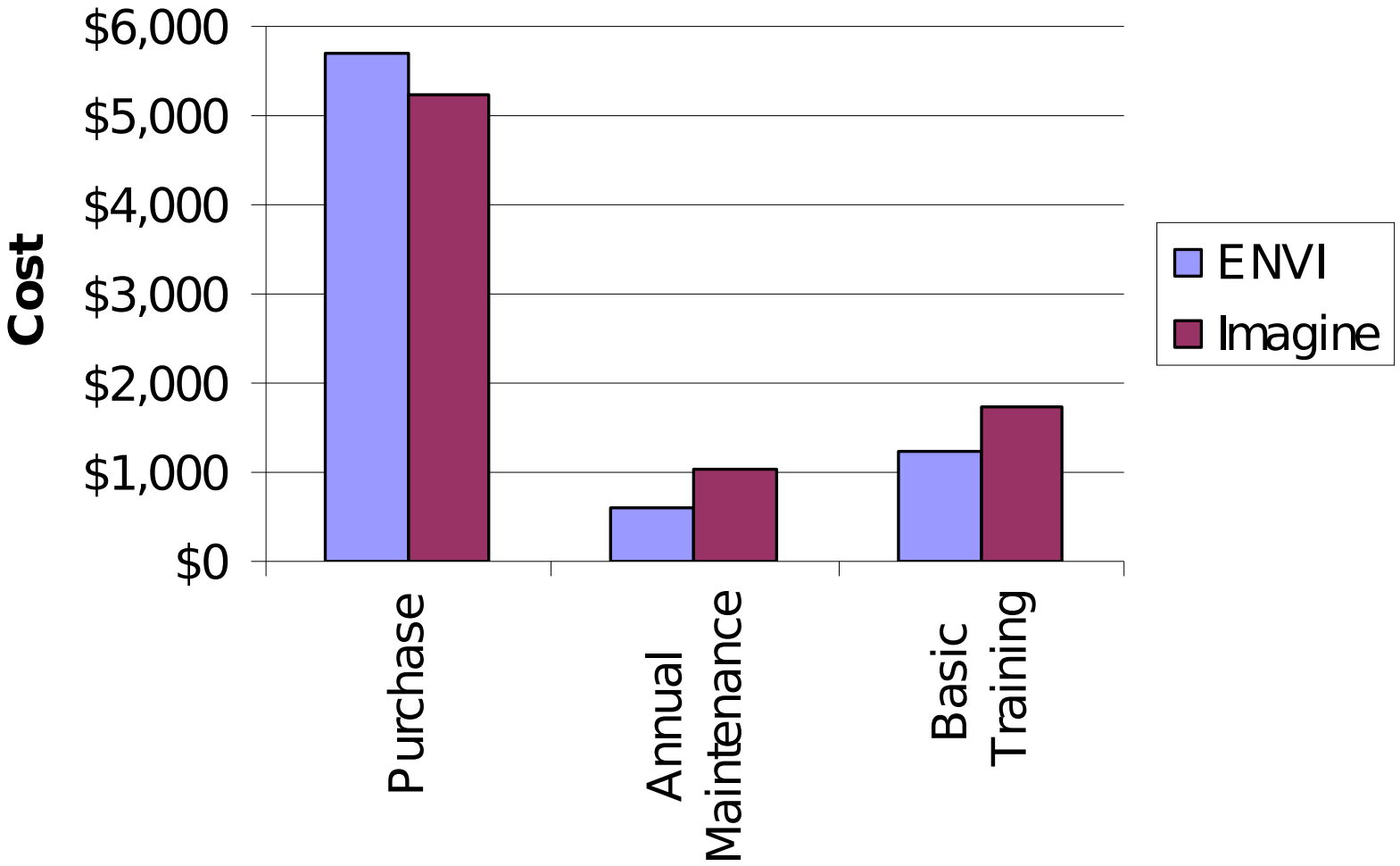
Imagine 1st Impressions

Cons

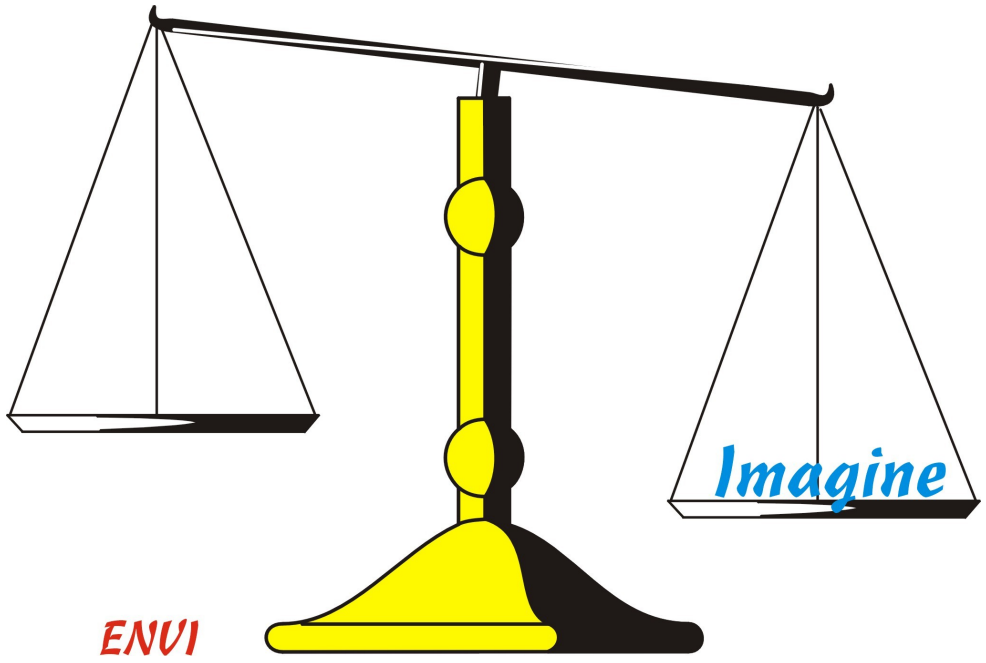
- Not as strong in multi-spectral analysis
- Online help files slower and less informative.



Cost Comparison

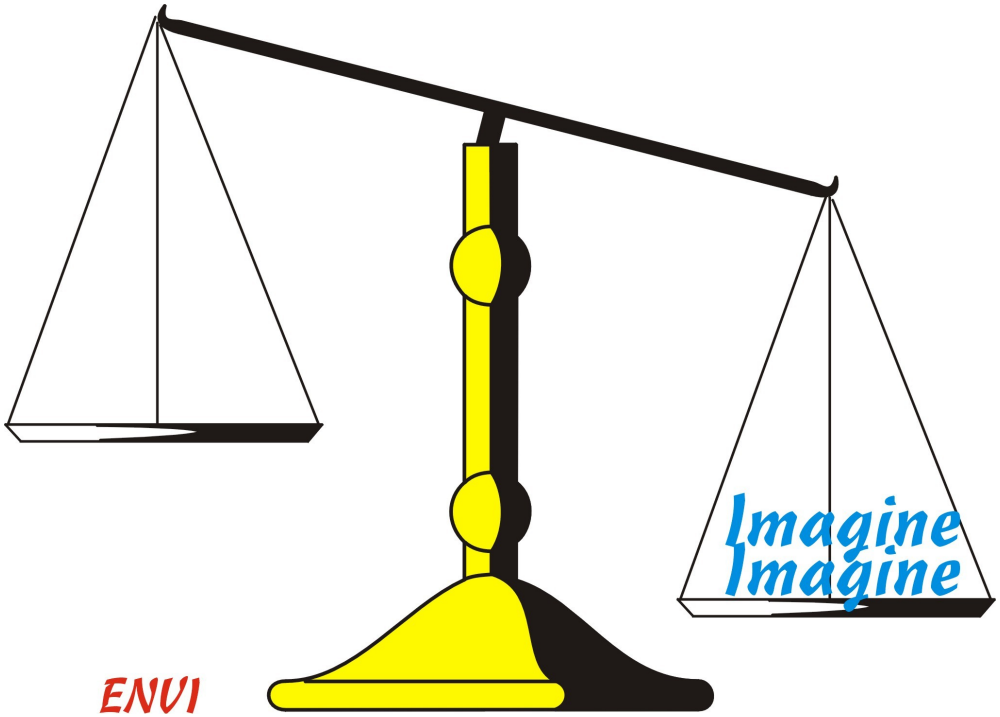


Which package is for us?



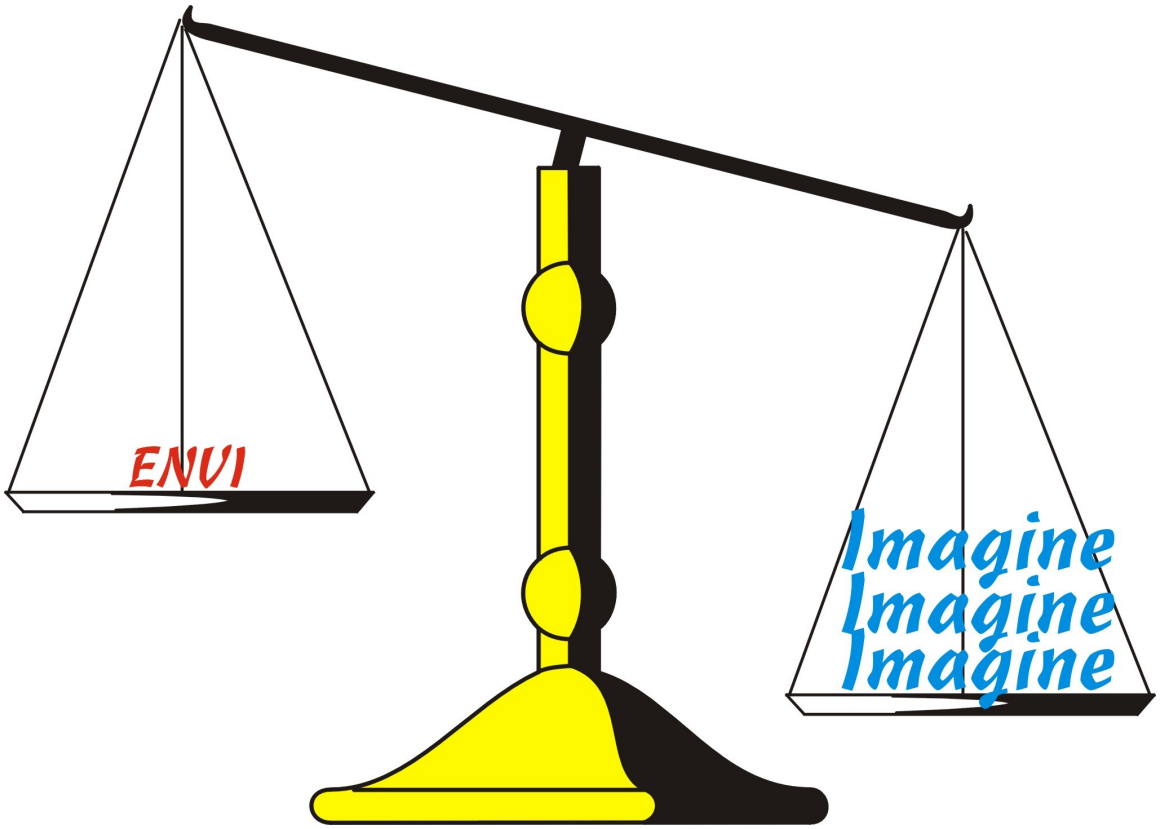
Appropriate for the job: Imagine

Which package is for us?



Fit to the user:
Imagine

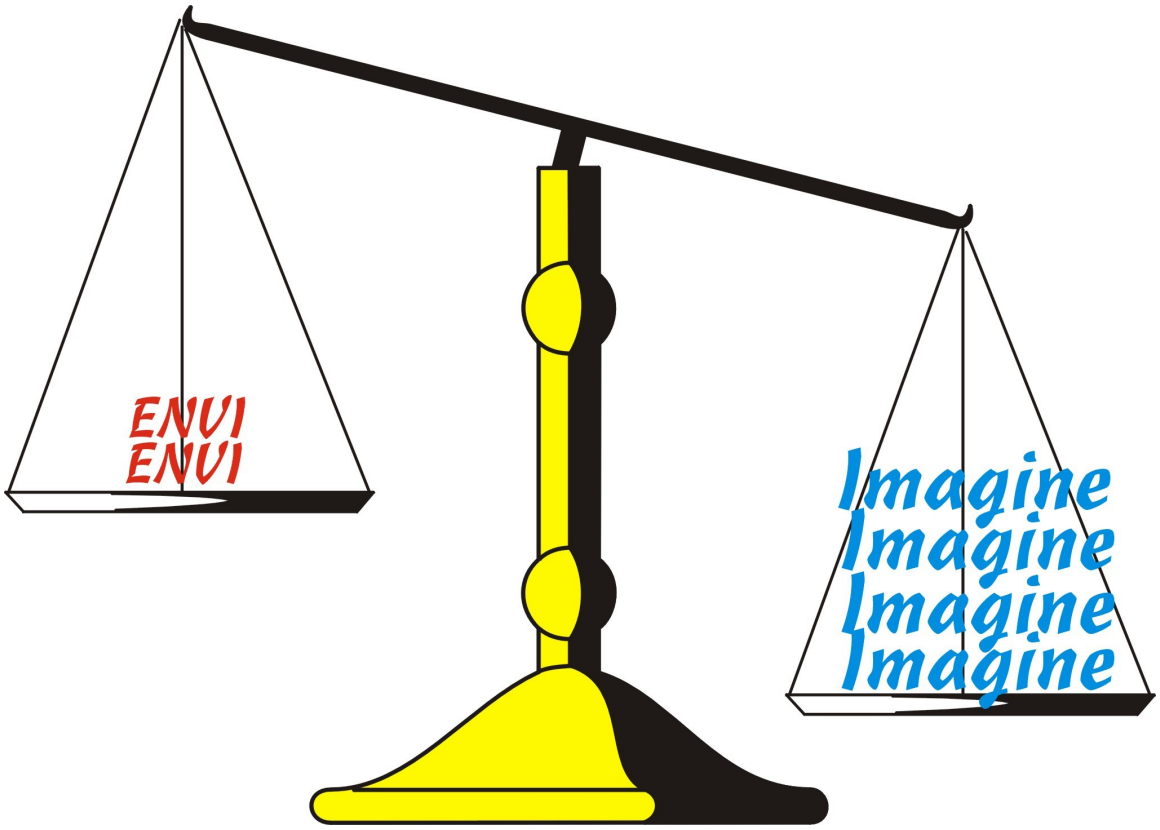
Which package is for us?



Cost:

Tie

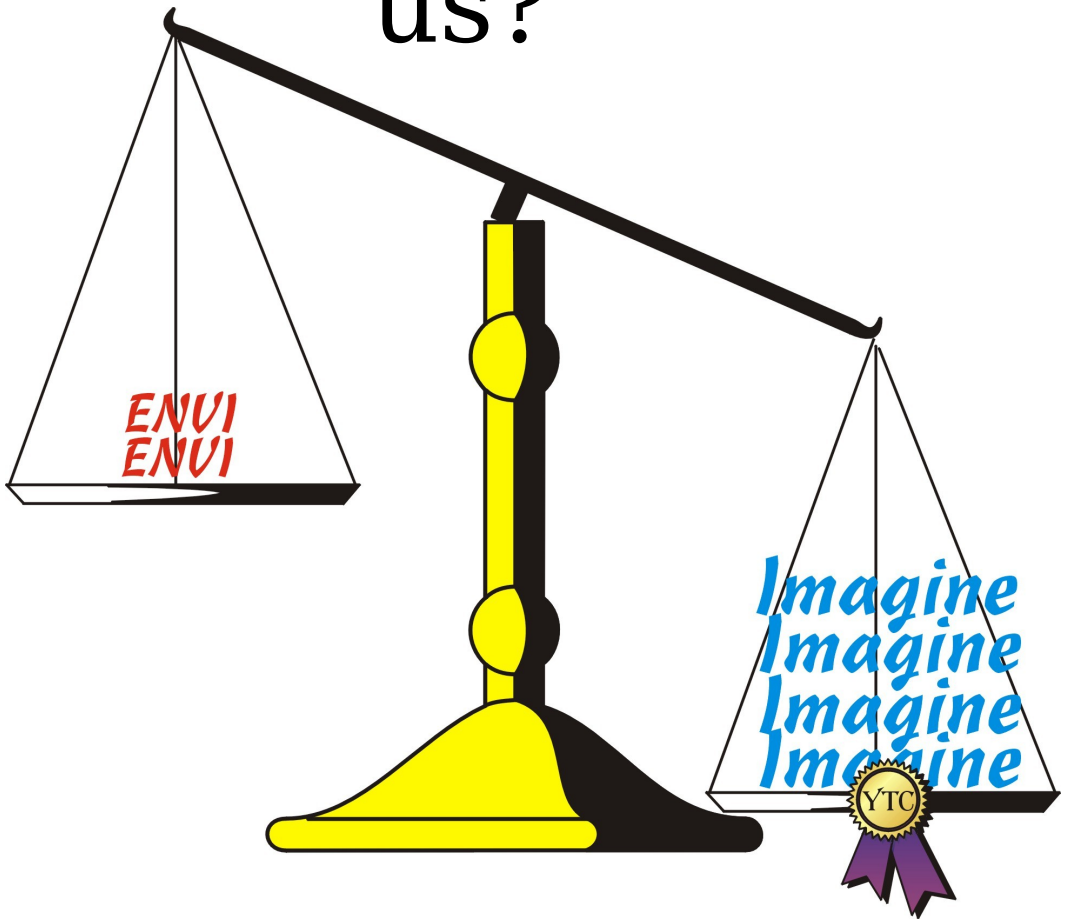
Which package is for us?



- Easy to learn:

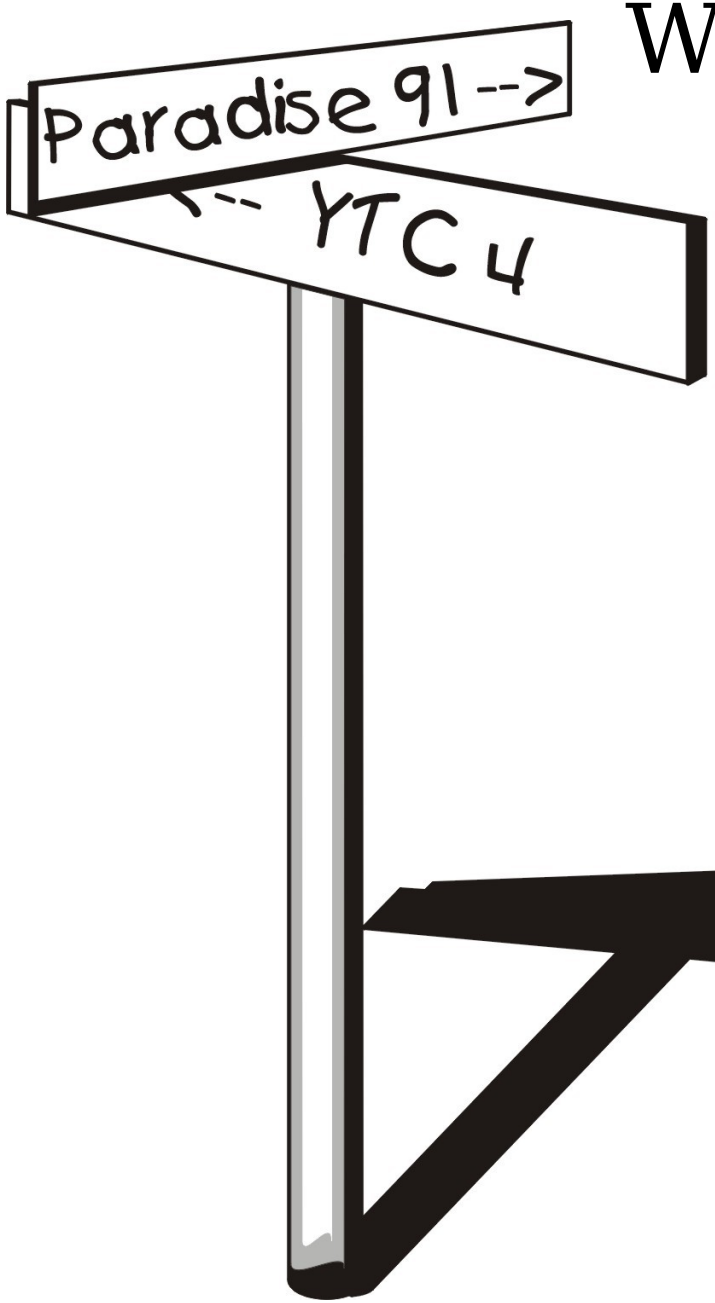
Tie

Which package is for us?



- Durable and complementary to other tools in the box. Imagine

Where do we go from here?



- We <u>can</u> do the analyses. Fire analysis will take some tutorial time with PNNL.
- Relatively minimal time.
- Leave the cutting edge projects for PNNL.
- Invest in software and training.

- Evaluate current image products.
- Define accuracy for the products.

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Questions